determining a deformation of an inner layer of the second region of the tissue in the pre-operative imaging data based on the identified correspondences by applying the biomechanical model with the personalized biomechanical parameters.

2. The method as recited in claim **1**, wherein extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data comprises:

determining an initial deformation in the first region of the tissue in the pre-operative imaging data by applying the biomechanical model with standard biomechanical parameters;

comparing the initial deformation in the first region of the tissue in the pre-operative imaging data with the first region of the tissue in the intra-operative imaging data; and

iteratively updating biomechanical parameters of the biomechanical model based on the comparing to extract the personalized biomechanical parameters.

3. The method as recited in claim **2**, wherein the standard biomechanical parameters include biomechanical parameters determined based on a population of patients.

4. The method as recited in claim **1**, wherein:

the first region of the tissue is a region of higher imaging accuracy in the inner layer of the tissue in the intra-operative imaging data, and

the second region of the tissue is a region of lower imaging accuracy in the inner layer of the tissue in the intra-operative imaging data.

5. The method as recited in claim **1**, wherein:

the outer layer of the tissue includes a cortical layer of a brain of the patient, and

the inner layer of the tissue include a subcortical layer of the brain of the patient.

6. The method as recited in claim **1**, wherein extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data comprises:

extracting personalized tissue elasticity and Poisson ratio of the patient.

7. The method as recited in claim **1**, further comprising:

updating the personalized biomechanical parameters based on a model of tumor growth for the patient.

8. An apparatus for image registration, comprising:

means for extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data;

means for identifying correspondences between an outer layer of a second region of the tissue in the pre-operative imaging data and the outer layer of the second region of the tissue in the intra-operative imaging data; and

means for determining a deformation of an inner layer of the second region of the tissue in the pre-operative imaging data based on the identified correspondences by applying the biomechanical model with the personalized biomechanical parameters.

9. The apparatus as recited in claim **8**, wherein the means for extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data comprises:

means for determining an initial deformation in the first region of the tissue in the pre-operative imaging data by applying the biomechanical model with standard biomechanical parameters;

means for comparing the initial deformation in the first region of the tissue in the pre-operative imaging data with the first region of the tissue in the intra-operative imaging data; and

means for iteratively updating biomechanical parameters of the biomechanical model based on the comparing to extract the personalized biomechanical parameters.

10. The apparatus as recited in claim **9**, wherein the standard biomechanical parameters include biomechanical parameters determined based on a population of patients.

11. The apparatus as recited in claim **9**, wherein the means for extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data comprises:

means for extracting personalized tissue elasticity and Poisson ratio of the patient.

12. The apparatus as recited in claim **9**, further comprising:

means for updating the personalized biomechanical parameters based on a model of tumor growth for the patient.

13. A non-transitory computer readable medium storing computer program instructions for image registration, the computer program instructions when executed by a processor cause the processor to perform operations comprising:

extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data;

identifying correspondences between an outer layer of a second region of the tissue in the pre-operative imaging data and the outer layer of the second region of the tissue in the intra-operative imaging data; and

determining a deformation of an inner layer of the second region of the tissue in the pre-operative imaging data based on the identified correspondences by applying the biomechanical model with the personalized biomechanical parameters.

14. The non-transitory computer readable medium as recited in claim **13**, wherein extracting personalized biomechanical parameters from a first region of tissue of a patient in an inverse problem of the biomechanical model using pre-operative imaging data and intra-operative imaging data comprises:

determining an initial deformation in the first region of the tissue in the pre-operative imaging data by applying the biomechanical model with standard biomechanical parameters;

comparing the initial deformation in the first region of the tissue in the pre-operative imaging data with the first region of the tissue in the intra-operative imaging data; and

iteratively updating biomechanical parameters of the biomechanical model based on the comparing to extract the personalized biomechanical parameters.